

WHAT IS CLAIMED IS:

1. A method of fabricating a photonic crystal, comprising the step of forming the photonic crystal directly on an end surface of at least one optical fiber as a substrate.

2. The photonic crystal fabricating method according to claim 1, wherein

the forming step includes the steps of:

5 tying a plurality of optical fibers in bundle with each end surface aligned on a same plane to form an optical fiber bundle; and

growing the photonic crystal directly on an end surface of said optical fiber bundle formed by the end surfaces of the optical fibers aligned on the same plane as the substrate,

10 by separating said optical fiber bundle into the optical fibers, the photonic crystal formed on said each end surface of the optical fibers is obtained.

3. The photonic crystal fabricating method according to claim 1, comprising the steps of:

processing the end surface of the optical fiber so that the end surface forms a predetermined angle with an optical axis  
5 of the optical fiber; and

growing the photonic crystal directly on said processed

end surface as the substrate in a direction normal to the end surface.

4. The photonic crystal fabricating method according to claim 1, wherein

said photonic crystal is grown on said substrate by periodically multilayering particles having a refractive index  
5 higher than air on said substrate in a direction normal to said substrate.

5. The photonic crystal fabricating method according to claim 1, wherein

a pattern is formed on said substrate for arbitrarily arranging particles having a refractive index higher than air on  
5 said substrate.

6. A method of fabricating a photonic crystal, comprising the step of forming the photonic crystal by making, in a predetermined section along an optical axis of an optical fiber composed of a core through which light propagate and a clad  
5 surrounding the core, a plurality of columns penetrate through said core.

7. The photonic crystal fabricating method according to claim 6, comprising the steps of:

partially removing said clad in said predetermined section from said optical fiber to form at least one plane parallel

5 to said optical axis; and

forming, perpendicularly to said plane formed in said removing step, a plurality of holes penetrating said core.

8. An optical transmission member for transmitting light having a predetermined wavelength, comprising:

an optical fiber for transmitting the light inputted at one end surface thereof to another end surface thereof for

5 output; and

a photonic crystal layer formed on at least either one of the end surfaces of said optical fiber and functioning as a linear polarizer for the light having said wavelength.

9. An optical transmission member for transmitting light having a predetermined wavelength, comprising:

an optical fiber for transmitting the light inputted at one end surface thereof to another end surface thereof for

5 output; and

a photonic crystal layer formed on at least either one of the end surfaces of said optical fiber and functioning as a  $\lambda/4$  plate for the light having said wavelength.

10. An optical transmission member for transmitting

light having a predetermined wavelength, comprising:

an optical fiber for transmitting the light inputted  
at one end surface thereof to another end surface thereof for  
5 output; and

a photonic crystal layer formed on at least either one  
of the end surfaces of said optical fiber and functioning as a  
photonic-crystal circular polarizer for the light having said  
wavelength.

11. The optical transmission member according to claim  
10, wherein

said photonic-crystal circular polarizer includes:

a first photonic crystal layer functioning as a  
5 polarizer for converting unpolarized light of said wavelength  
into linearly polarized light; and

a second photonic crystal layer functioning as a  $\lambda$   
/4 plate for converting the linearly polarized light of said  
wavelength obtained through said first photonic crystal layer  
10 into circularly polarized light.

12. The optical transmission member according to claim  
10, wherein

said photonic-crystal circular polarizer is formed as  
photonic crystal layers having a periodic structure in which a  
5 high magnetic permeability portion having first magnetic

permeability and a low magnetic permeability portion having second magnetic permeability lower than the first magnetic permeability.

13. An optical device structured by forming a photonic crystal on an optical fiber composed of a core through which light propagate and a clad surrounding the core, comprising:

5 at least one functional part formed as said photonic crystal with a plurality of columns penetrating through said core in a predetermined section of said optical fiber along an optical axis of said optical fiber; and

a propagation part for propagating the light as a function of said optical fiber.

14. The optical device according to claim 13, wherein said functional part is formed by the plurality of columns parallel to each other and periodically distributed on a plane perpendicular to a longitudinal direction of said columns.

15. The optical device according to claim 13, wherein said plurality of columns forming said functional part penetrate through said core and said clad of said optical fiber.

16. The optical device according to claim 13, wherein said plurality of columns forming said functional part

have a refractive index different from a refractive index of material forming said core.

17. The optical device according to claim 16, wherein all or part of said plurality of columns forming said functional part is a hole.

18. The optical device according to claim 16, wherein all or part of said plurality of columns forming said functional part is made of material having a Faraday effect.

19. The optical device according to claim 18, further comprising a magnetic field generator for applying a magnetic field to said functional part.

20. The optical device according to claim 16, wherein all or part of said plurality of columns forming said functional part is made of material having an electro-optic effect.

21. The optical device according to claim 20, further comprising electrodes for applying an electric field to said functional part.

22. The optical device according to claim 21, wherein

said electrodes are provided on a surface formed by partially removing said clad.

23. The optical device according to claim 22, wherein said electrodes are provided in pair on a surface perpendicular to a longitudinal direction of said plurality of columns forming said functional part.

24. The optical device according to claim 23, wherein said electrodes are provided in pair on two surfaces parallel and opposed to each other with said functional part therebetween, and perpendicular to the longitudinal direction of said plurality of columns forming said functional part.

25. The optical device according to claim 22, wherein said electrodes are provided in pair on two surfaces parallel and opposed to each other with said functional part therebetween, and parallel to said optical axis and the longitudinal direction of said plurality of columns forming said functional part.

26. The optical device according to claim 21, wherein said electrodes are arranged to apply said electric field to said functional part in a direction parallel to the optical axis of said optical fiber.

27. The optical device according to claim 21, wherein  
said electrodes are arranged to apply said electric  
field to said functional part perpendicularly to a longitudinal  
direction of said plurality of columns forming said functional  
5 part and the optical axis of said optical fiber.

28. The optical device according to claim 21, wherein  
said electrodes are arranged to apply the electric  
field to form a predetermined angle with a longitudinal direction  
of said plurality of columns along a plane perpendicular to said  
5 optical axis.

29. The optical device according to claim 13, wherein  
said functional part is plurally provided along the  
optical axis of said optical fiber at predetermined intervals.

30. The optical device according to claim 29, wherein  
said functional part includes  
a first functional part composed of a plurality of  
columns parallel to each other and periodically distributed on  
5 a plane perpendicular to a longitudinal direction of the columns,  
said columns made of a Faraday crystal having a refractive index  
different from a refractive index of material forming said core;  
and

a second functional part composed of a plurality of



10 holes parallel to each other and distributed on a plane  
perpendicular to a longitudinal direction of the holes, and  
the longitudinal direction of said plurality of columns  
forming said first functional part forms an angle of  $45^\circ$  with the  
longitudinal direction of said holes forming said second  
15 functional part along a plane perpendicular to said optical axis.

31. The optical device according to claim 29, wherein  
said functional part includes

a first functional part composed of a plurality of  
columns parallel to each other and periodically distributed on  
a plane perpendicular to a longitudinal direction of the columns,  
said columns made of an electro-optic crystal having a refractive  
5 index different from a refractive index of material forming said  
core; and

a second functional part composed of a plurality of  
first holes parallel to each other and distributed on a plane  
perpendicular to a longitudinal direction of the first holes, and

10 the longitudinal direction of said plurality of columns  
forming said first functional part is perpendicular or parallel  
to the longitudinal direction of said first holes forming said  
second functional part along a plane perpendicular to said optical  
axis.

32. The optical device according to claim 31, wherein

said functional part further comprises a third functional part composed of a plurality of second holes parallel to each other and periodically distributed on a plane in a longitudinal direction of the second holes, and

the longitudinal direction of said plurality of columns forming said first functional part is perpendicular or parallel to the longitudinal direction of said second holes forming said third functional part along the plane perpendicular to said optical axis.

33. The optical device according to claim 13, wherein said functional part is formed as a photonic crystal with a predetermined refractive index and state of distribution, to have a wavelength dispersion characteristic of recovering a waveform of the light to be a steep waveform for output, the light being spread by a wavelength dispersion characteristic unique to an optical fiber through which the light passed before inputted to said optical fiber.

34. The optical device according to claim 13, further comprising a guide for surrounding said optical fiber, wherein said guide is cylindrically shaped having a diameter approximately equal to a diameter of a ferrule of another optical fiber connected to said optical fiber.

35. An optical device, comprising:

first and second optical fibers formed by a plurality of holes parallel to each other penetrating through the core in a predetermined section along an optical axis and periodically distributed on a plane perpendicular to a longitudinal direction of the holes;

a Faraday device placed to be closely attached between said first and second optical fibers; and

a guide for mechanically adjusting an optical axis of said first optical fiber and an optical axis of said second optical fiber, wherein

a longitudinal direction of said holes of said first optical fiber forms an angle of  $45^\circ$  with a longitudinal direction of said holes of said second optical fiber along a plane perpendicular to said optical axis.

36. An optical sensor including a light-emitting part for emitting a light beam; a sensor part including circular polarizer means for converting unpolarized light into circularly polarized light, an electro-optic crystal film, and an analyzer sequentially arranged on a predetermined optical axis set along an optical path of said light beam; and a light-receiving part for receiving said light beam after passing through said sensor part, said optical sensor for measuring, based on said light beam received by said light-receiving part, a voltage applied to said

10 electro-optic crystal film, wherein

said light-emitting part includes a first optical fiber  
for inducing said light beam into said sensor part,

said light-receiving part includes a second optical  
fiber for inducing, from said sensor part, said light beam after  
15 passing therethrough,

said circular polarizer means includes

a polarizer for converting the unpolarized light  
into linearly polarized light; and

a  $\lambda/4$  plate for converting the linearly polarized  
20 light into the circularly polarized light,

said polarizer is formed on an end surface of said first  
optical fiber as a photonic crystal layer for converting said  
light beam from said light-emitting part into a linearly polarized  
beam, and

25 said analyzer is formed on an end surface of said second  
optical fiber as a photonic crystal layer for converting said  
light beam after passing through said sensor part into a linearly  
polarized beam.

37. The optical sensor according to claim 36, wherein

said  $\lambda/4$  plate is formed on said polarizer as a photonic  
crystal layer for converting said linearly polarized light beam  
obtained by said polarizer into a circularly polarized light beam.

38. The optical sensor according to claim 36, further comprising:

a first reflective film having a reflection plane perpendicular to said optical axis and placed between said circular polarizer means and said electro-optic crystal film;

a second reflective film having a reflection plane perpendicular to said optical axis and placed between said electro-optic crystal film and said analyzer; and

a substrate on which said sensor part is mounted, wherein

an interval between said first reflective film and said second reflective film is an integer multiple of half a wavelength of said light beam,

said substrate includes

a component guide for positioning said first reflective film, said electro-optic crystal film, and said second reflective film on said optical axis;

a first fiber guide for positioning said first optical fiber to optically couple said circular polarizer means as the photonic crystal layer formed in said first optical fiber to said first reflective film; and

a second fiber guide for positioning said second optical fiber to optically couple said analyzer as the photonic crystal layer formed in said second optical fiber to said second reflective film.

39. The optical sensor according to claim 36, further comprising:

a first reflective film having a reflection plane perpendicular to said optical axis and placed between said circular polarizer means and said electro-optic crystal film; and

a second reflective film having a reflection plane perpendicular to said optical axis and placed between said electro-optic crystal film and said analyzer, wherein

an interval between said first reflective film and said second reflective film is an integer multiple of half a wavelength of said light beam.

40. An optical sensor including a light-emitting part for emitting a light beam; a sensor part including circular polarizer means for converting unpolarized light into circularly polarized light, an electro-optic crystal film, and an analyzer sequentially arranged on a predetermined optical axis set along an optical path of said light beam; and a light-receiving part for receiving said light beam after passing through said sensor part, said optical sensor for measuring, based on said light beam received by said light-receiving part, a voltage applied to said electro-optic crystal film, wherein

said light-emitting part includes a first optical fiber for inducing said light beam into said sensor part,

said light-receiving part includes a second optical

fiber for inducing, from said sensor part, said light beam after  
15 passing therethrough,

said circular polarizer means is formed on an end  
surface of said first optical fiber as a photonic crystal layer  
for converting said light beam from said light-emitting part into  
a circularly polarized beam, and

20 said analyzer is formed on an end surface of said second  
optical fiber as a photonic crystal layer for converting said  
light beam after passing through said sensor part into a linearly  
polarized beam.

41. The optical sensor according to claim 40, further  
comprising:

a first reflective film having a reflection plane  
perpendicular to said optical axis and placed between said  
5 circular polarizer means and said electro-optic crystal film; and

a second reflective film having a reflection plane  
perpendicular to said optical axis and placed between said  
electro-optic crystal film and said analyzer, wherein

an interval between said first reflective film and said  
10 second reflective film is an integer multiple of half a wavelength  
of said light beam.

42. The optical sensor according to claim 40, further  
comprising:

a first reflective film having a reflection plane perpendicular to said optical axis and placed between said  $\lambda$

5  $\lambda/4$  plate and said electro-optic crystal film;

a second reflective film having a reflection plane perpendicular to said optical axis and placed between said electro-optic crystal film and said analyzer; and

a substrate on which said sensor part is mounted,

10 wherein

an interval between said first reflective film and said second reflective film is an integer multiple of half a wavelength of said light beam, and

said substrate includes

15 a component guide for positioning said  $\lambda/4$  plate, said first reflective film, said electro-optic crystal film, and said second reflective film on said optical axis;

a first fiber guide for positioning said first optical fiber to optically couple said circular polarizer means  
20 as the photonic crystal layer formed in said first optical fiber to said  $\lambda/4$  plate; and

a second fiber guide for positioning said second optical fiber to optically couple said analyzer as the photonic layer formed in said second optical fiber to said second  
25 reflective film.

43. The optical sensor according to claim 40, further



comprising:

a first reflective film having a reflection plane perpendicular to said optical axis and placed between said circular polarizer means and said electro-optic crystal film;

a second reflective film having a reflection plane perpendicular to said optical axis and placed between said electro-optic crystal film and said analyzer; and

a substrate on which said sensor part is mounted, wherein,

an interval between said first reflective film and said second reflective film is an integer multiple of half a wavelength of said light beam, and

said substrate includes

a component guide for positioning said first reflective film, said electro-optic crystal film, and said second reflective film on said optical axis;

a first fiber guide for positioning said first optical fiber to optically couple said circular polarizer means as the photonic crystal layer formed in said first optical fiber to said first reflective film; and

a second fiber guide for positioning said second optical fiber to optically couple said analyzer as the photonic crystal layer formed in said second optical fiber to said second reflective film.

44. An optical sensor including a light-emitting part for emitting a light beam; a sensor part including a polarizer, a magneto-optic crystal film, and an analyzer sequentially arranged on a predetermined optical axis set along an optical path  
5 of said light beam; and a light-receiving part for receiving said light beam after passing through said sensor part, said optical sensor for measuring, based on said light beam received by said light-receiving part, a voltage applied to said magneto-optic crystal film, wherein

10           said light-emitting part includes a first optical fiber for inducing said light beam into said sensor part,

          said light-receiving part includes a second optical fiber for inducing said light beam for said sensor part,

          said polarizer is formed on an end surface of said first  
15 optical fiber as a photonic crystal layer for converting said light beams from said light-emitting part into a linearly polarized light beam, and

          said analyzer is formed on an end surface of said second  
optical fiber as a photonic crystal layer for converting into said  
20 light beams after passing through said sensor part into a linearly polarized beam.

45. The optical sensor according to claim 44, further comprising

          a substrate on which said sensor part is mounted,

wherein

5           said substrate includes

          a component guide for positioning said magneto-optic crystal film on said optical axis;

          a first fiber guide for positioning said first optical fiber to optically couple said polarizer as the photonic crystal layer formed in said first optical fiber to said  
10           magneto-optic crystal film; and

          a second fiber guide for positioning said second optical fiber to optically couple said analyzer as the photonic crystal layer formed in said second optical fiber to said  
15           magneto-optic crystal film.

46. An optical sensor including a light-emitting part for emitting a light beam; a sensor part including a polarizer, a  $\lambda/4$  plate, an electro-optic crystal, and an analyzer sequentially arranged on a predetermined optical axis set along  
5           an optical path of said light beam; and a light-receiving part for receiving said light beam after passing through said sensor part, said optical sensor for measuring, based on said light beam received by said light-receiving part, a voltage applied to said electro-optic crystal, said optical sensor further comprising:  
10           a first reflective film having a reflection plane perpendicular to said optical axis and placed between said  $\lambda/4$  plate and said electro-optic crystal; and

a second reflective film having a reflection plane perpendicular to said optical axis and placed between said  
15 electro-optic crystal and said analyzer, wherein

an interval between said first reflective film and said second reflective film is an integer multiple of half a wavelength of said light beam.

47. The optical sensor according to claim 46, wherein said first and second reflective films are conductive, and

said voltage to be measured is applied between said  
5 first reflective film and said second reflective film.

48. The optical sensor according to claim 47, wherein said electro-optic crystal and said  $\lambda/4$  plate are placed so that a direction of a fast-axis for an ellipse indicative of a refractive index of said electro-optic crystal with respect  
5 to said light beam is equal to a direction of a fast-axis for an ellipse indicative of a refractive index of said  $\lambda/4$  plate with respect to said light beam.

49. The optical sensor according to claim 47, wherein at least one of said first and second reflective film is an conductive reflective film composed of a transparent conductive film and a reflective film, and

5 an interval between said first reflective film and said second reflective film is an integer multiple of half a wavelength of said light beam.

50. The optical sensor according to claim 46, wherein said first and second reflective films are multilayered films each formed by alternately multilayering a high-refractive-index layer having a first refractive index, and a  
5 low-refractive-index layer having a second refractive index lower than the first refractive index,

a sum of a thickness of said high-refractive-index layer and a thickness of said low-refractive-index layer is one-quarter the wavelength of said light beam,

10 a first adjacent layer composing said first reflective film closest to said electro-optic crystal and a second adjacent layer composing said second reflective film closest to said electro-optic crystal are same in type, and

an interval between said first adjacent layer and said  
15 second adjacent layer is the integer multiple of half the wavelength of said light beam.

51. The optical sensor according to claim 46, further comprising

a substrate on which said sensor part is mounted, wherein

5           said light-emitting part includes a first optical fiber  
for inducing said light beam into said sensor part,

          said light-receiving part includes a second optical  
fiber for inducing, from said sensor part, said light beam after  
passing therethrough, and

10           said substrate includes

          a component guide for positioning said polarizer,  
said  $\lambda/4$  plate, said first reflective film, said electro-optic  
crystal film, said second reflective film, and said analyzer on  
said optical axis;

15           a first fiber guide for positioning said first  
optical fiber to optically couple said first optical fiber to said  
polarizer; and

          a second fiber guide for positioning said second  
optical fiber to optically couple said second optical fiber to  
20   said analyzer.

52. The optical sensor according to claim 46, further  
comprising

          a pair of electrodes for applying said voltage to be  
measured to said electro-optic crystal perpendicularly to said  
5   optical axis.

53. The optical sensor according to claim 46, further  
comprising:

a functional part including said  $\lambda/4$  plate, said first reflective film, said electro-optic crystal, and said second  
5 reflective film;

a first optical propagation part including a first optical fiber, a first lens, and said polarizer for inducing said light beam into said functional part; and

a second optical propagation part including a second  
10 optical fiber, a second lens, and said analyzer for inducing, from said functional part, said light beam after passing therethrough, wherein

said  $\lambda/4$  plate, said first reflective film, said electro-optic crystal, and said second reflective film forming  
15 said functional part are held between said polarizer forming said first optical propagation part and said analyzer forming said second optical propagation part, by friction produced on surfaces in contact with each other.